DESCRIPTION

FLUID PRESSURE APPARATUS

[0001] Technical Field

[0002] The present invention relates to a fluid pressure apparatus in which both ports of a fluid pressure pump, driven by an electric motor and rotatable in both directions, are respectively connected to both ports of a fluid pressure actuator through a pair of pipe lines.

[0003] Background Art

[0004] There are known conventional fluid pressure apparatus, such as one shown in Publication of Unexamined Japanese Patent Application No. 10-26101 (page 2, FIG. 2), in which both ports of a fluid pressure pump driven, by an electric motor and rotatable in both directions, are respectively connected to both ports of a fluid pressure actuator through a pair of pipe lines. In this fluid pressure apparatus, a fluid pressure tank and a pair of pipe lines are connected through check valves oriented in respective directions to allow the flow from the fluid pressure tank. The sealed fluid pressure tank is preloaded by introducing air pressure.

[0005] According to such a conventional fluid pressure

apparatus, however, a supply pipe connected to an air pressure source is connected to the sealed fluid pressure tank, and air pressure is introduced directly to the sealed fluid pressure tank. This leads to a problem that in the installation of the fluid pressure tank, it is necessary for an air layer formed in the fluid pressure tank to be located in an upper position. In other words, the installation position of the fluid pressure tank is restricted.

[0006] An object of the present invention is to provide a fluid pressure apparatus whose installation position is not restricted.

[0007] Disclosure of Invention

[0008] To achieve the above mentioned object, the present invention has taken the following measures: there is provided a fluid pressure apparatus provided with a fluid pressure pump driven by an electric motor and rotatable in both directions, both ports of a fluid pressure actuator and both ports of the fluid pressure pump being respectively connected through a pair of pipe lines, wherein a sliding cavity is formed between an outer cylinder and an inner cylinder. The sliding cavity is divided into a preload chamber and a tank chamber by a piston slidably inserted in the sliding cavity. The tank

chamber and the pair of pipe lines are connected through check valves respectively provided in directions so as to allow discharge from the tank chamber. The tank chamber is preloaded with the air pressure introduced into the preload chamber, and the fluid pressure pump is disposed in the inner cylinder.

[0009] The fluid pressure pump may be a swash plate pump. Also, it may be possible to arrange the outer cylinder and the inner cylinder coaxially with a rotating shaft of the electric motor, and mount the outer cylinder and the inner cylinder on the electric motor. Furthermore, the tank chamber may communicate with the inside of the inner cylinder. Alternatively, a top end of the rotating shaft of the electric motor may be rotatably supported by a lid member closing one end of the outer cylinder and one end of the inner cylinder.

[0010] Brief Description of Drawings

[0011] Fig. 1 is a cross-sectional view of a fluid pressure apparatus as an embodiment of the present invention; and

[0012] Fig. 2 is a hydraulic circuit diagram of the fluid pressure apparatus according to the present embodiment.

[0013] Best Mode for Carrying Out the Invention

[0014] An embodiment of the present invention will be

described below in detail based on the drawings.

[0015] As shown in FIG. 2, a fluid pressure pump 1 is a swash plate piston pump that can be rotated in both directions. During a rotation in a forward direction, an operating fluid is drawn in from the side of a first port 2 and discharged from the side of a second port 4. During a rotation in a reverse direction, the operating fluid is drawn in from the side of the second port 4 and discharged from the side of the first port 2. The fluid pressure pump 1 is connected so as to be rotationally driven by an electric motor 6, such as a servomotor.

[0016] A head side pipe line 8 and a rod side pipe line 10 are respectively connected to the first port 2 and the second port 4. The head side pipe line 8 is connected to a head side port 14 of a fluid pressure cylinder 12 of a single-rod type, while the rod side pipe line 10 is connected to a rod side port 16 of the fluid pressure cylinder 12. Other than the fluid pressure cylinder 12 of a single-rod type, any fluid actuator may be employed, such as a fluid pressure cylinder of a double-rod type and a fluid pressure motor .

[0017] An after-mentioned tank chamber 18 is connected to the head side pipe line 8 through a pilot check valve 20. The pilot check valve 20 is oriented in a direction to allow the flow from the tank chamber 18 toward the head side

pipe line 8. The pilot check valve 20 is connected so as to introduce the fluid pressure in the rod side pipe line 10 as a pilot pressure, and be opened to make the head side pipe line 8 communicate with the tank chamber 18 when the fluid pressure in the rod side pipe line 10 is increased.

[0018] Also, the rod side pipe line 10 is connected to the tank chamber 18 through a pilot check valve 22. The pilot valve 22 is oriented in a direction to allow the flow from the tank chamber 18 toward the rod side pipe line 10. The pilot check valve 22 is connected so as to introduce the fluid pressure in the head side pipe line 8 as a pilot pressure, and be opened to make the rod side pipe line 10 communicate with the tank chamber 18 when the fluid pressure in the head side pipe line 8 is increased. In the present embodiment, the head side pipe line 8 and the rod side pipe line 10 are connected to the tank chamber 18 through relief valves 24, 26, respectively. The relief valves 24, 26 may be provided when necessary.

[0019] As shown in FIG. 1, there is provided a tank body 36 including a tubular outer cylinder 32 and a tubular inner cylinder 34 having a smaller diameter than the outer cylinder 32 and being formed within the outer cylinder 32. The outer diameter of the outer cylinder 32 is designed to be approximately the same as the outer diameter of the electric motor 6. The outer cylinder 32 and the inner

cylinder 34 are arranged coaxially with each other.

[0020] A ring-shaped sliding cavity 38 is formed between the outer cylinder 32 and the inner cylinder 34, one end of the ring-shaped sliding cavity 38 being closed by a wall 40.

[0021] The wall 40 is mounted on one end of the electric motor 6, and thereby the tank body 36 is fixed to the electric motor 6. A rotating shaft 42 of the electric motor 6 is provided so as to be positioned coaxially with the outer cylinder 32 and the inner cylinder 34.

[0022] A ring-shaped piston 44 sealed by O-rings 46, 48 is slidably inserted in the sliding cavity 38. The sliding cavity 38 is divided into a preload chamber 50, on the side of the wall 40, and the tank chamber 18 by the piston 44. A lid member 52 is mounted to the other end of the sliding cavity 38 defined by the outer cylinder 32 and the inner cylinder 34, thereby closing the tank chamber 18. The lid member 52 is also inserted inside the inner circumference of the inner cylinder 34 so as to rotatably support a top end of the rotating shaft 42, through a bearing 54.

[0023] A pump chamber 56 is formed by being enclosed by the inner cylinder 34, the wall 40, and the lid member 52. The rotating shaft 42, sealed by a seal 57, penetrates the pump chamber 56. A cylinder block 58, engagingly

attached to and integrally rotatable with the rotating shaft 42, is disposed within the pump chamber 56. The cylinder block 58 is provided with a plurality of cylinder holes 60 bored in the axial direction. Through holes 62 are respectively bored adjacent to the cylinder holes 60, and pistons 64 are slidably inserted into the respective cylinder holes 60, so that cylinder chambers 66 are formed by the cylinder holes 60 and the pistons 64.

[0024] A valve plate 68 is provided between the cylinder block 58 and the lid member 52, such that the through holes 62 may communicate with the first port 2 and the second port 4 through a not-shown pair of port holes formed in the valve plate 68 in accordance with the rotation of the cylinder block 58

[0025] On the other hand, a shoe 70, provided to be spherically connected to one end of each of the pistons 64, is designed to slide on an anti-friction member 74 attached to a swash plate 72. The swash plate 72 is firmly attached to the wall 40 of the tank body 36 so as to be restricted from rotation.

[0026] A coil spring 76, housed in the preload chamber 50, biases the piston 44 toward the tank chamber 18. The preload chamber 50, which is connected to a connection port 78, is connected to an air pressure source 80 through the connection port 78. The tank chamber 18,

communicating with the pump chamber 56 through a communication path 82, is connected to the above-mentioned pilot check valves 20 and 22, and relief valves 24 and 26, through a connecting duct 84.

[0027] Next, the operation of the above described fluid apparatus in the present embodiment will be described.

[0028] When the electric motor 6 is rotated in a forward direction, the rotating shaft 42 rotates together with the cylinder block 58. This causes each shoe 70 to slide on the anti-friction member 74 and each piston 64 to slide within the sliding hole 60 in accordance with the inclination of the swash plate 72, thereby changing the volume of the cylinder chamber 66. So that, an operating fluid is drawn through the first port 2 and a pressure fluid is discharged through the second port 4.

[0029] Accordingly, the operating fluid is drawn from the head side port 14 of the fluid pressure cylinder 12 through the head side pipe line 8 into the first port 2 of the fluid pressure pump 1. Also, the pressure fluid is supplied from the second port 4, through the rod side pipe line 10, and the rod side port 16 to the fluid pressure cylinder 12.

[0030] Then, a cylinder rod 86 is driven in a pulling direction. In this case, the amount of the operating fluid discharged from the head side port 14 is different from the amount of the pressure fluid flowing in from the rod side

port 16 by the volume of the cylinder rod 86. The excess amount of the operating fluid is discharged through the head side pipe line 8 to the tank chamber 18, since the pilot check valve 20 is opened by the operation of the pilot pressure from the rod side pipe line 10. In this regard, the operation speed and the moving amount of the fluid pressure cylinder 12 can be controlled by controlling the electric motor 6.

【0031】 When the electric motor 6 is rotated in a reverse direction, the operating fluid is drawn from the second port 4 of the fluid pressure pump 1 through the rod side port 16 of the fluid pressure cylinder 12, and the rod side pipe line 10, while the pressure fluid is supplied to the fluid pressure cylinder 12 through the first port 2, the head side pipe line 8, and the head side port 14. Accordingly, the cylinder rod 86 is driven in a pushing direction.

【0032】 In this case, the amount of the operating fluid discharged from the rod side port 16 is different from the amount of the pressure fluid flowing in from the head side port 14 by the volume of the cylinder rod 86 in the same manner as described above. The deficient amount of the operating fluid is supplied from the tank chamber 18 to the rod side pipe line 10 through the pilot check valve 22, since the pressure in the rod side pipe line 10 is decreased,

and thereby the pilot check valve 22 is opened. Specifically, the operating fluid is supplied to the rod side pipe line 10 through the pilot check valve 22 due to the preload applied to the tank chamber 18, which prevents the occurrence of cavitation on the drawing side of the fluid pressure pump 1.

[0033] In contrast, when the rotation of the electric motor 6 is stopped, the pressure fluid is not discharged from the fluid pressure pump 1. Accordingly, both pilot check valves 20 and 20 are opened by the operating fluid pressure in the tank chamber 18 due to the preload of the compressed air from the air pressure source 80. Thereby, the pressure in the tank chamber 18 is introduced into the head side pipe line 8 and the rod side pipe line 10.

[0034] As a result, the fluid pressure is introduced through both ports 14 and 16 of the fluid pressure cylinder 12, and the cylinder rod 86 is made difficult to move by a small external force even if the external force is applied to the cylinder rod 86 and, therefore, is prevented from deflecting. Also, since the tank chamber 18 is preloaded by the piston 44 regardless of the installation position of the tank body 36, there is no restriction on the installation position of the fluid pressure apparatus. In addition, since the circular tank chamber 18 is provided outside the fluid pressure pump 1, a sufficient volume of

the tank chamber 18 can be secured and downsizing of the fluid pressure apparatus can be achieved.

【0035】 The present invention is not limited to the above described embodiment, but may be practiced in various forms within the scope and not depart from the gist of the present invention.

【0036】 As described in detail above, the fluid pressure apparatus of the present invention presents an advantage that an appropriate preload pressure can be applied regardless of its installation position as well as an advantage that downsizing can be achieved.

【0037】 Industrial Applicability

【0038】 According to the present invention, there is provided a fluid pressure apparatus capable of applying an appropriate preload pressure regardless of its installation position and capable of being downsized.